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# A-LEVEL

# Mathematics

Statistics 1B – MS1B

Mark scheme

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6360  
June 2014

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Version/Stage: Final

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Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from [aqa.org.uk](http://aqa.org.uk)

### Key to mark scheme abbreviations

|              |  |
|--------------|--|
| M            | mark is for method   |
| m or dM      | mark is dependent on one or more M marks and is for method         |
| A            | mark is dependent on M or m marks and is for accuracy              |
| B            | mark is independent of M or m marks and is for method and accuracy |
| E            | mark is for explanation  |
| ✓ or ft or F | follow through from previous incorrect result                      |
| CAO          | correct answer only  |
| CSO          | correct solution only  |
| AWFW         | anything which falls within  |
| AWRT         | anything which rounds to   |
| ACF          | any correct form   |
| AG           | answer given   |
| SC           | special case   |
| OE           | or equivalent  |
| A2,1         | 2 or 1 (or 0) accuracy marks                                       |
| -x EE        | deduct x marks for each error                                      |
| NMS          | no method shown  |
| PI           | possibly implied   |
| SCA          | substantially correct approach                                     |
| c            | candidate  |
| sf           | significant figure(s)  |
| dp           | decimal place(s)   |

### No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

**Otherwise we require evidence of a correct method for any marks to be awarded.**

| Q                                    | Solution   | Marks   | Total                | Comments   |
|--------------------------------------|--|---|----------------------|--|
| <b>1</b><br><b>(a)</b><br><b>(i)</b> | No MR or MC in this question   |   |                      | Ignore units throughout this question  |
|                                      | Mode = <u>71</u><br><br>Range = <u>9</u>   | B1<br><br>B1  | <br><br><b>2</b>     | CAO; ignore any reference to 8<br><br>CAO  |
| <b>Note</b>                          | 1 If answers are not identified, then assume that order of values is mode, range                                 |   |                      |  |
| <b>(ii)</b>                          | Median = <u>70</u><br><br>IQR = <u>3</u><br><br>UQ = <u>72</u> LQ = <u>69</u>                                    | B1<br><br>B2<br><br>(B1)  | <br><br><br><b>3</b> | CAO<br><br>CAO; providing not from incorrect working eg see Note 1<br><br>Both values CAO; ignore labels   |
|                                      | <b>Notes</b>   | 1 Ordering of weeks (1, 1, 2, 2, 2, 3, 4, 5, 7, 8) $\Rightarrow$ median = 2.5 $\Rightarrow$ B0 B0 even if IQR = 3 (5 – 2)<br>2 If answers are not identified, then assume that order of values is median, IQR   |                      |  |
| <b>(iii)</b>                         | Mean = <u>70.4</u><br><br>Mean = <u>70.1 to 70.7</u><br><br>SD = <u>2.03 or 2.06</u><br><br>SD = <u>2 to 2.1</u> | B2<br><br>(B1)<br><br>B2<br><br>(B1)  | <br><br><br><b>4</b> | CAO<br><br>AWFW; but exclude 70.5 unless with a <b>correct method</b> (see <b>Note 2</b> )<br><br>Either AWRT (2.0312 or 2.0608)<br><br>AWFW   |
|                                      | <b>Notes</b>   | 1 $\sum fx = 2464$ and $\sum fx^2 = 173610$<br>2 Using only $x$ -values gives Mean = 70.5 and SD = 3.16 or 3.32 $\Rightarrow$ B0 B0<br>3 Using only $f$ -values gives Mean = 3.18 and SD = 2.44 or 2.56 $\Rightarrow$ B0 B0<br>4 If, and only if, B0 B0, then award M1 for <b>seen</b> attempt at $\sum fx \div 35$ or for $2464 \div 35$       |                      |  |
| <b>(b)</b>                           | Henrietta keeps $(x - 60)$ so:<br><br>Mean = <u>10.4</u><br><br>SD = <u>2.03 or 2.06</u>                         | BF1<br><br>BF1  | <br><br><br><b>2</b> | FT on any mean $> 60$ from (a)(iii) but must <b>subtract 60</b> and state <b>numerical</b> value $> 0$<br><br>FT on any SD $> 0$ from (a)(iii) but must state <b>unchanged numerical</b> value $> 0$ |
|                                      | <b>Notes</b>   | 1 Mean is “60 fewer” than previously/in (a)(iii) (OE) $\Rightarrow$ BF0<br>2 SD is “exactly same” as previously/in (a)(iii) (OE) $\Rightarrow$ BF0<br>3 If mean and SD calculated using $(x - 60)$ , $\sum f(x - 60) = 364$ and $\sum f(x - 60)^2 = 3930$ , then, to score marks, the answers must be 10.4 (CAO) and 2.03 (AWRT) or 2.06 (AWRT) |                      |  |
|                                      |  | <b>Total</b>  | <b>11</b>            |  |

| Q            | Solution   | Marks          | Total      | Comments  |
|--------------|--|----------------|------------|---|
| <b>2</b>     | <b>No MR or MC in this question</b>  |                |            | <b>Accept %age equivalents in (a)(i) to (iii)</b>   |
| <b>(a)</b>   | <u>Length, <math>X \sim N(1.86, 0.04^2)</math></u>   |                |            |   |
| <b>(i)</b>   | $P(X < 1.90) = P\left(Z < \frac{1.90 - 1.86}{0.04}\right)$ $= P(Z < 1) = \underline{\mathbf{0.841}}$   | M1<br>A1       | <b>(2)</b> | Standardising 1.90 with 1.86 and 0.04 but allow (1.86 – 1.90)<br>AWRT (0.84134)   |
| <b>(ii)</b>  | $P(X > 1.80) = P(Z > -1.5) = P(Z < 1.5)$ $= \underline{\mathbf{0.933}}$  | M1<br>A1       | <b>(2)</b> | <b>Correct</b> area change; <b>neither</b> 1.5 or correct standardising are required<br>Can be implied by <b>final answer &gt; 0.5</b><br>AWRT (0.93319)  |
| <b>(iii)</b> | $P(1.80 < X < 1.90) = P(Z < 1) - P(Z < -1.5) =$ <p><b>or</b></p> $(i) - [1 - (ii)] \text{ or } (ii) - [1 - (i)]$ $(i) + (ii) - 1$ $= \underline{\mathbf{0.774 to 0.775}}$  | M1<br>A1       | <b>(2)</b> | OE; any <b>correct</b> difference in areas that results in <b>answer &gt; 0</b><br>Can be implied by <b>correct answer</b> but see Notes<br>AWFW (0.77453)  |
| <b>Notes</b> | <b>1</b> If answer to (ii) is 0.06681, then use of (i) – (ii) = 0.84134 – 0.06681 = 0.774 to 0.775 $\Rightarrow$ M0 A0<br><b>2</b> If answer to (ii) is 0.06681, but answer here starts afresh with $P(1.80 < X < 1.90)$ , then M1 A1 is available                           |                |            |   |
| <b>(iv)</b>  | $P(X \neq 1.86) = \underline{\mathbf{1 \text{ or one or unity or } 100\%}}$  | B1             | <b>(1)</b> | CAO; accept nothing else but ignore zeros after decimal place (eg 1.00)<br>Ignore additional words providing that they are not contradictory (eg certain so = 1)  |
| <b>Note</b>  | <b>1</b> $P(X \neq 1.86) = P(Z \neq 0) \Rightarrow$ B0 unless followed by 1 OE   |                |            |   |
|              |  |                | <b>7</b>   |   |
| <b>(b)</b>   | $0.98 \Rightarrow z = \underline{\mathbf{2.05 to 2.06}}$ $\left(\frac{1.80 - 1.86}{\sigma}\right) \Leftrightarrow \begin{pmatrix} -2.05 \text{ to } -2.06 \\ \text{or} \\ -2.32 \text{ to } -2.33 \end{pmatrix}$ $\sigma \Leftrightarrow \underline{\mathbf{0.029 to 0.03}}$ | B1<br>M1<br>A1 | <b>3</b>   | AWFW; seen anywhere, ignore sign (2.0537)<br>Standardising 1.80 with 1.86 and $\sigma$ or $s$ but allow (1.86 – 1.80); <b>and</b> equating to a <b>z-value</b> in either range ( <i>ignore sign</i> )<br>AWFW (0.02922)<br>If working is shown, then there must be consistent signs throughout so, for example, $(1.80 - 1.86)/\sigma = +2.0537 \Rightarrow$ B1 M1 A0 |
| <b>Note</b>  | <b>1</b> Allow use of 1.92 instead of 1.80 so $(1.92 - 1.86)/\sigma = +2.0537 \Rightarrow$ B1 M1 (A1)  |                |            |   |
|              |  |                |            |   |
|              |  | <b>Total</b>   | <b>10</b>  |   |

| Q   | Solution  | Marks   | Total      | Comments  |  |
|---|---|---|------------|---|--|
| <b>3</b><br><b>Notes for part (a)</b>   | <b>No MR or MC in this question except as indicated in the following Notes</b>  |   |            |   |  |
|   | <b>1</b> If <b>correct</b> fraction, percentage or ratio is followed by incorrect decimal, then apply ISW but apply penalties as in Notes 2 to 5  |   |            |   |  |
|   | <b>2</b> At least one <b>decimal answer</b> given to more than 3 dp (including 0.0320) <b>or</b> at least one <b>recurring decimal answer</b> (eg 0.29 $\bar{3}$ or 0.29 $\dot{0}$ ) are penalised by <b>1 mark</b>   |   |            |   |  |
|   | <b>3</b> At least one <b>fractional</b> answer (eg 22/75) is penalised by <b>1 mark</b>   |   |            |   |  |
|   | <b>4</b> At least one <b>percentage</b> answer (eg 29.3) is penalised by <b>1 mark</b>  |   |            |   |  |
| <b>5</b> At least one <b>ratio</b> answer (eg 22:75) is penalised by <b>2 marks</b>                                       |   |   |            |   |  |
| Mark answers as below and then apply MR-1 or MR-2 as appropriate (if available) at end of question before totalling marks |   |   |            |   |  |
| <b>(a)(i)</b>   | $P(\text{FH}) = \underline{\underline{220/750 = 22/75 = 0.293}}$  | B1  | <b>(1)</b> | CAO/AWRT (0.29333)  |  |
| <b>(ii)</b>   | $P(\text{AH} \cap \text{BE}) = \underline{\underline{24/750 = 8/250 = 4/125 = 0.032}}$  | B1  | <b>(1)</b> | CAO   |  |
| <b>(iii)</b>  | $P(\text{AH} \cup \text{BE} \text{ but not both}) = \frac{110 + 215 - 2 \times 24}{750}$<br>$= \underline{\underline{277/750 = 0.369}}$   | M1  | <b>(2)</b> | OE<br>Can be implied by <b>correct answer</b>   |  |
|   |   | A1  |            | CAO/AWRT (0.36933)  |  |
| <b>SC</b>   | Award B1 for 301/750 <b>or</b> 0.401(33)  |   |            |   |  |
| <b>(iv)</b>   | $P(\text{GE}   \text{FH}) = \frac{64}{750} / \frac{220}{750} =$<br>$\underline{\underline{64/220 = 32/110 = 16/55 = 0.291}}$  | M1  | <b>(2)</b> | OE<br>Can be implied by <b>correct answer</b>   |  |
|   |   | A1  |            | CAO/AWRT (0.29091)  |  |
| <b>(v)</b>  | $P(\text{FH}   \text{GE}) = \frac{64}{750} / \frac{195}{750} =$<br>$\underline{\underline{64/195 = 0.328}}$   | M1  | <b>(2)</b> | OE<br>Can be implied by <b>correct answer</b>   |  |
|   |   | A1  |            | CAO/AWRT (0.32821)  |  |
| <b>SC</b>   | If, and only if, answers to (iv) & (v) are <b>correct but reversed</b> , then award M1 A0 M1 A0   |   |            |   |  |
|   |   |   | <b>8</b>   |   |  |
| <b>(b)</b><br><b>Notes</b>  | $P((\text{DH} \cap \text{BE}) \cap (\text{DH} \cap \text{BE}) \cap (\text{MH} \cap \text{GE})) =$<br>$\frac{92}{750} \times \frac{91}{749} \times \frac{55}{748}$<br><br>Multiplied by 3<br><b>or</b><br>$\binom{92}{2} \binom{55}{1} \div \binom{750}{3}$<br><br>$= \underline{\underline{0.00328 \text{ to } 0.00329}}$ | M1<br>M1<br><br>m1<br><br>(M1 M1)<br>(M1)<br><br>A1 | <b>4</b>   | Correct 3 values multiplied in numerator<br>Correct 3 values multiplied in denominator<br>0.123 $\times$ 0.121 $\times$ 0.074 (all AWRT)<br>$\Rightarrow$ M1 M1 (OE products)<br>Dependent on at least one M1 scored<br><br>Numerator<br>Denominator<br><br>AWFW (0.00328752) |  |
|   | <b>1</b> Incorrect answer with no working $\Rightarrow$ 0 marks   |   |            |   |  |
|   | <b>2</b> The <b>3 correct fractions or decimals</b> identified but not multiplied (eg added) $\Rightarrow$ M1 M0 m0 A0  |   |            |   |  |
|   | <b>3</b> The <b>3 correct fractions or decimals</b> identified along with 0.0011 (AWRT) $\Rightarrow$ M1 M1 m0 A0   |   |            |   |  |
|   | <b>4</b> Do <b>not</b> penalise a <b>correct answer</b> given to more than 3sf  |   |            |   |  |
| <b>5</b> Answer given as $3.28 \times 10^{-3}$ to $3.29 \times 10^{-3}$ $\Rightarrow$ M1 M1 m1 A1                         |   |   |            |   |  |
|   |   | <b>Total</b>  | <b>12</b>  |   |  |

| Q               | Solution  | Marks                    | Total    | Comments  |
|-----------------|---|--------------------------|----------|---|
| 4<br>(a)<br>(i) | No MR or MC in this question  |                          |          |   |
|                 | $r_{uv} = \underline{\underline{0.915}}$ $= \underline{\underline{0.9 \text{ to } 0.92}}$ $= \underline{\underline{0.8 \text{ to } 0.99}}$  | B3<br>(B2)<br>(B1)       |          | AWRT<br>AWFW<br>AWFW<br>(0.91468)   |
|                 | Attempt at $\sum u$ $\sum u^2$ $\sum v$ $\sum v^2$ & $\sum uv$<br>or<br>Attempt at $S_{uu}$ $S_{vv}$ & $S_{uv}$<br>Attempt at substitution into <b>correct</b> corresponding formula for $r_{uv}$<br>$r_{uv} = \underline{\underline{0.915}}$   | (M1)<br><br>(m1)<br>(A1) | <b>3</b> | 81.58 808.2288 70.11 632.3553 & <b>701.6158</b> (all 5 attempted)<br><br>142.69916 140.81409 & <b>129.65842</b> (all 3 attempted)<br><br>AWRT                           |
| (ii)            | $r_{xy} = \underline{\underline{0.915}}$  | BF1                      |          | F on (i) providing $-1 < r_{uv} < +1$<br>Value quoted must be 0.915(AWRT)<br><b>or</b> identical to answer in (i)   |
| Notes           | 1 Award on value only; ignore any explanation or working<br>3 Calculating $r_{xy}$ using values of $x$ & $y \Rightarrow$ B1 only if $r_{xy} = 0.915$ (AWRT)   |                          |          | 2 $r_{xy} = r_{uv}$ with no value stated $\Rightarrow$ B0   |
| Notes           | $r$ is <b>not affected</b> by <b>linear scaling</b><br>or<br><b>Scaling/coding/transformation/change/conversion</b> to $u$ and $v$ is <b>linear</b>   | Bdep1                    |          | OE; accept "Formula" or "It" for $r$ but reference to " <b>linear</b> " is necessary<br><br>Dependent on BF1<br><br>OE; but reference to " <b>linear</b> " is necessary |
|                 | 1 All values changed using (same) <b>linear</b> scale/formula $\Rightarrow$ B1<br>3 <b>Linear</b> formula has no effect on $r \Rightarrow$ B1<br>5 $r$ is not affected by units (June 2013!) $\Rightarrow$ B0   |                          |          | 2 All values changed using (same) scale/formula/-100 $\Rightarrow$ B0<br>4 Formula has no effect on $r \Rightarrow$ B0  |
|                 |   |                          | <b>2</b> |   |
| (b)             | (Very) <b>strong positive</b> (linear) <b>correlation</b>   | Bdep1                    |          | Dependent on<br><b><math>0.8 \leq (r_{xy} \text{ or } r_{uv}) \leq 0.99</math></b><br>OE; must <b>qualify strength</b> and <b>state positive</b>                        |
| Notes           | 1 Only accept phrase stated; ignore additional comments unless contradictory<br>2 Use of: "quite/fairly/extremely/relatively strong or high or big or good or moderate or medium or average" $\Rightarrow$ Bdep0<br>3 Accept "relationship/association/link" but not "trend" instead of "correlation" |                          |          |   |
| Notes           | between<br><br>(average) <b>qualifying speed</b> and<br>(average) <b>race speed</b>   | B1                       |          | Context;<br>providing $-1 < (r_{xy} \text{ or } r_{uv}) < 1$  |
|                 | 1 Accept "qualifying mph" and "race mph" but <b>not</b> "mph" without identification<br>2 Accept "fastest/qualifying lap" and "three/ race laps"  |                          |          |   |
|                 |   | <b>Total</b>             | <b>7</b> |   |

| Q                                    | Solution  | Marks        | Total     | Comments   |
|--------------------------------------|---|--------------|-----------|--|
| <b>5</b><br><b>(a)</b><br><b>(i)</b> | No MR or MC in this question  |              |           | Accept percentage equivalents in (a)   |
|                                      | $p(0) = \underline{\mathbf{0.18}}$  | B1           |           | CAO; can be implied from working or <b>correct answer</b>  |
|                                      | $P(H=3) = \binom{30}{3}(p)^3(1-p)^{27}$<br><br>$= \underline{\mathbf{0.111 \text{ to } 0.112}}$   | M1<br><br>A1 |           | Correct expression using $p = \mathbf{0.18, 0.47, 0.25 \text{ or } 0.10}$<br>Can be implied by <b>correct answer</b><br>Ignore extra terms<br><br>AWFW (0.11151) |
| <b>(ii)</b>                          | $p(\geq 3) = \underline{\mathbf{0.1}}$  | B1           |           | CAO; can be implied from working or <b>correct answer</b>  |
|                                      | $P(H \leq 5) = \underline{\mathbf{0.926 \text{ to } 0.927}}$  | B1           |           | AWFW (0.9268)  |
| <b>(iii)</b>                         | $p(\geq 2) = \underline{\mathbf{0.35}}$   | B1           |           | CAO; can be implied from 0.5078 or 0.3575 (accept 3dp rounding) or <b>correct answer</b>   |
|                                      | $P(H > 10) = \underline{\mathbf{1 - (0.5078 \text{ or } 0.3575)}}$  | M1           |           | Requires "1 - either probability"<br>Accept 3 dp rounding<br>Can be implied by (0.492)<br>but <b>not</b> by (0.642 to 0.643)                                     |
|                                      | $= \underline{\mathbf{0.492}}$  | A1           |           | AWRT (0.4922)  |
| <b>SC</b>                            | For calculation of individual terms: award B1 B2 for 0.492 (AWRT); award B1 for 0.642 to 0.643 (AWFW)   |              |           |  |
| <b>(iv)</b>                          | $p(=2) = \underline{\mathbf{0.25}}$   |              |           |  |
|                                      | $P(5 < H < 10) = \mathbf{0.8034 \text{ or } 0.8943}$ ( $p_1$ )  | M1           |           | Accept 3 dp rounding<br>Can be implied by <b>correct answer</b>  |
|                                      | <b>MINUS</b> $\mathbf{0.2026 \text{ or } 0.0979}$ ( $p_2$ )<br><br>$= \underline{\mathbf{0.6 \text{ to } 0.601}}$   | M1<br><br>A1 |           | Accept 3 dp rounding<br>Can be implied by <b>correct answer</b><br><br>AWFW (0.6008)   |
| <b>Notes</b>                         | <b>1</b> First M1 is for ( $+p_1$ ) in calculation <b>2</b> Second M1 is for ( $-p_2$ ) in calculation <b>3</b> $(1-p_2) - (1-p_1) \Rightarrow$ M1 M1 (A1)<br><b>4</b> B(30, 0.25) probabilities shown for <b>at least 3</b> values within $4 \leq X \leq 10 \Rightarrow$ M2 May be implied by a <b>correct answer</b><br>Ans = <u><b>0.6 to 0.601</b></u> $\Rightarrow$ A1 |              |           |  |
|                                      |   |              |           |  |
|                                      |   |              |           |  |
| <b>(b)</b>                           | Mean ( $\mu$ or $\bar{x}$ ) = <u><b>108</b></u>   | B1           |           | CAO; B(150, 0.72)  |
|                                      | Variance ( $\sigma^2$ or $s^2$ ) = <u><b>30.2 to 30.3</b></u>   | B1           |           | AWFW (30.24)   |
| <b>Notes</b>                         | <b>1</b> If answers are not identified, then assume that order of values is mean, variance<br><b>2</b> If 30.2 to 30.3 labelled as SD ( $\sigma$ or $s$ ) $\Rightarrow$ B0  |              |           |  |
|                                      |   |              |           |  |
|                                      |   | <b>Total</b> | <b>13</b> |  |



| Q             | Solution  | Marks  | Total      | Comments  |
|---------------|---|--|------------|---|
| <b>6</b>      | <b>No MR or MC in this question</b>   | <b>Accept height but not length instead of depth throughout question</b> |            |   |
| <b>(a)(i)</b> | $a = \underline{15}$  | B1   | <b>1</b>   | CAO; eg $14.9 \Rightarrow 15 \Rightarrow B0$  |
| <b>(ii)</b>   | $b$ (gradient/slope) = $\underline{-0.029}$<br>$b$ (gradient/slope) = $\underline{-0.025 \text{ to } -0.035}$<br><br>$a$ (intercept) = $\underline{14.9}$<br>$a$ (intercept) = $\underline{14 \text{ to } 16}$  | B2<br>(B1)<br><br>B2<br>(B1)   | <b>4</b>   | AWRT (-0.02903)<br>AWFW<br><br>AWRT (14.90968)<br>AWFW  |
|               | Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$<br><b>or</b><br>Attempt at $S_{xx}$ & $S_{yy}$<br>Attempt at <b>correct</b> formula for $b$<br>$b = \underline{-0.029}$ (AWRT) $a = \underline{14.9}$ (AWRT)  | (M1)<br><br>(m1)<br>(A1 A1)  |            | $1450$ $280000$ $107$ & $13490$<br>(all 4 attempted) ( $\sum y^2 = 1204.42$ )<br><br>$69750$ & $-2025$<br>(both attempted) ( $S_{yy} = 59.52$ )<br><br>$(\bar{x} = 145 \text{ \& } \bar{y} = 10.7)$ |
| <b>Notes</b>  | <b>1</b> Treat rounding of correct answers as ISW <b>2</b> Written form of equation is <b>not</b> required<br><b>3</b> Award 4 marks for $y = 14.9 - 0.029x$ <b>or</b> $y = 14.9 + -0.029x$ <b>or</b> $14.9 - 0.029x$ <b>or</b> $14.9 + -0.029x$<br><b>4</b> Values of $a$ and $b$ interchanged and equation $y = ax + b$ stated in (a)(ii) $\Rightarrow$ max of 4 marks<br><b>5</b> Values of $a$ and $b$ interchanged with no equation stated <b>or</b> equation $y = a + bx$ stated in (a)(ii) $\Rightarrow$ 0 marks<br><b>6</b> Values of $a$ and $b$ are <b>not</b> identified, then $-0.025$ to $-0.035 \Rightarrow B1$ and $14$ to $16 \Rightarrow B1$<br><b>7</b> Answers in fractions can score maximum of M1 m1<br><b>8</b> Some/all of marks can be scored in (a)(iii) & (b) & (c), even if some/all of marks are lost in (a)(ii), but marks lost in (a)(ii) <b>cannot</b> be recouped by subsequent working in (a)(iii) or (b) or (c)(ii) |  |            |   |
| <b>(iii)</b>  | Seal <b>depth reduces/decreases</b> by <b>0.03 (AWRT)</b> when <b>pressure increases by 1</b><br><b>-0.03 (AWRT)</b> when <b>pressure increases by 1</b><br><br><b>or</b><br>(y, cm) <b>reduces/decreases</b> as (x, kPa) <b>increases</b>  | B1<br>Bdep1<br>(Bdep0)<br><br>(B1)                                       | <b>2</b>   | OE; must be in context<br>OE; must be in context<br>(double negative)<br><br>OE; context <b>not</b> required<br>B0 for reference only to correlation  |
| <b>Note</b>   | <b>1</b> To score any marks, an explanation must indicate change in $x$ affecting $y$ , <b>not</b> change in $y$ affecting $x$  |  |            |   |
| <b>(b)</b>    | $y_{225} = \underline{8.3 \text{ to } 8.4}$<br>$y_{225} = \underline{6.1 \text{ to } 10.4}$   | B2<br>(B1)   | <b>2</b>   | AWFW but see Note 1 (8.37442)<br>AWFW; even if by $(9.0 + 7.5)/2$   |
| <b>Notes</b>  | <b>1</b> If an answer is in the range 8.3 to 8.4 <b>and seen</b> to be from other than the use of $y = 14.9 - 0.029x$ , then award B1 only<br><b>2</b> If, and only if, B0, then award M1 for seen use of $y = a + b \times 225$ <b>or</b> $y = 15 + b \times 225$  |  |            |   |
| <b>(c)(i)</b> | <b>Extrapolation/outside</b> (observed) range (of $x$ )   | B1   | <b>(1)</b> | OE  |
| <b>(ii)</b>   | <b>or</b><br>$y_{525} = \underline{-0.3 \text{ to } -0.4}$<br>$x_0 = \underline{510 \text{ to } 515}$<br><br><b>Negative seal depth is impossible</b><br>Seal is off/above/under/below the ground<br>Seal is within the barrier   | B1<br><br>Bdep1  | <b>(2)</b> | AWFW (-0.33226)<br>AWFW (513.59)<br><br>OE; must be in context<br>Dependent on B1<br>Negative value is impossible $\Rightarrow B0$  |
|               |   |  | <b>3</b>   |   |
|               |   | <b>Total</b>   | <b>12</b>  |   |

| Q               | Solution  | Marks  | Total     | Comments  |
|-----------------|---|--|-----------|---|
| 7<br>(a)<br>(i) | No MR or MC in this question  |  |           |   |
|                 | Attempt at $\bar{v} - n\sigma = 118 - 65n < 0$<br>and<br><b>negative usage/volume</b> is impossible   | M1<br>A1   | 2         | Allow 1.82, 2, 3 or 4 for $n$ with a <b>correct numerical answer</b><br>OE; must be in context<br>Negative value is impossible $\Rightarrow$ A0   |
| Notes           | <p>1 <math>n = 1.82 \Rightarrow \approx 0</math>; <math>n = 2 \Rightarrow -12</math>; <math>n = 3 \Rightarrow -77</math>; <math>n = 4 \Rightarrow -142</math></p> <p>2 Attempt at <math>P(V &lt; 0) = P\left(Z &lt; \frac{0-118}{65}\right)</math> or <math>\left(z = \pm \frac{0-118}{65}\right) \Rightarrow</math> M1 (Standardising 0 using 118 and 65)<br/> <math>\Rightarrow P(Z &lt; -1.81 \text{ to } 1.82) \Rightarrow</math> <b>0.03 to 0.04</b> (AWFW) <b>AND negative usage/volume</b> is impossible <math>\Rightarrow</math> A1<br/> <b>or</b> <math>\Rightarrow</math> 0 is (1.81 to 1.82)SDs from mean <b>AND negative usage/volume</b> is impossible <math>\Rightarrow</math> A1</p> |  |           |   |
| (ii)            | Sample (size/number/ $n$ ) is large<br><b>or</b><br>80/sample (size/number/ $n$ ) is greater than 25/30<br>so<br>can apply/use Central Limit Theorem (CLT)  | B1<br>Bdep1  | 2         | OE<br>OE; is sufficient/is enough/implies<br>Dependent on B1  |
|                 | Notes   | <p>1 Even if CLT is stated, then reference to parent population is thus normal <math>\Rightarrow</math> Bdep0</p> <p>2 Value(s) of (population) standard deviation (and mean) is/are known <math>\Rightarrow</math> B0 Bdep0</p> |           |   |
| (b)(i)          | 98% (0.98) $\Rightarrow z =$ <b>2.32 to 2.33</b>  | B1   |           | AWFW (2.3263)   |
|                 | CI for $\mu$ is:<br>$118 \pm \begin{pmatrix} 2.05 \text{ to } 2.06 \\ 2.32 \text{ to } 2.33 \\ 2.57 \text{ to } 2.58 \end{pmatrix} \times \frac{(65 \text{ or } 65.4(\text{AWRT}))}{\sqrt{80 \text{ or } 79}}$<br>Thus $118 \pm (2.32 \text{ to } 2.33) \times \frac{65}{\sqrt{80}}$<br>Hence <b>118 <math>\pm</math> 17</b><br><b>or</b><br><b>(101, 135)</b>  | M1<br>A1<br>Adep1  | 4         | Evaluation of only one CL $\Rightarrow$ M0<br>Ignore notation<br>$\sqrt{\frac{65^2 \times 80}{79}} = 65.4101$<br>Fully correct expression<br>CAO/AWRT (16.90574)<br>Dependent on A1<br>AWRT |
| Notes           | <p>1 A correct answer with no working <math>\Rightarrow</math> 4 marks</p> <p>2 Seen use of <math>t</math>-value (2.37 to 2.38) <math>\Rightarrow</math> 0 marks</p> <p>3 An incorrect expression for CI followed by a numerically correct CI <math>\Rightarrow</math> 2 solutions <math>\Rightarrow ((0 \text{ or } 1) + 4)/2 \Rightarrow</math> 2 marks</p>   |  |           |   |
| (ii)            | <b>Clear correct comparison of 140 with CI</b><br>eg<br>140 is outside/above CI <b>or</b> $140 > \text{UCL}$  | BF1  |           | F on CI providing it does <b>not</b> contain 140<br>Must be an <b>interval</b> but quoting values for limits is <b>not</b> required   |
|                 | Disagree with/doubt/reject <b>claim</b><br><b>or</b> $\mu$ unlikely to be/is not 140  | Bdep1  | 2         | OE; dependent on BF1  |
| Notes           | <p>1 Statement must clearly indicate that "140 is outside/above the CI" <b>or</b> "<math>140 &gt; \text{UCL}</math>"</p> <p>2 "It/mean/value/OE" is outside/above CI <b>or</b> greater than UCL <math>\Rightarrow</math> BF0</p> <p>3 Statements of the form "140 is outside/above 98% of the data/values" <math>\Rightarrow</math> BF0</p> <p>4 Statements such as "<b>Claim</b> unlikely/unreasonable/unsupported/incorrect/false/inaccurate/invalid" <math>\Rightarrow</math> Bdep1 but only if BF1 awarded</p>  |  |           |   |
|                 |   | <b>Total</b>   | <b>10</b> |   |